# THE COORDINATION OF REFRACTION
*WITH*
# SPECTACLE AND EYE GLASS FITTING

SIDNEY L. OLSHO. M.D.

THE COÖRDINATION OF REFRACTION
WITH
SPECTACLE AND EYE GLASS FITTING

DEDICATED

To

WILLIAM L. WALL

# The Coördination of Refraction
# with
# Spectacle and Eye Glass Fitting

THE SYSTEM OF BASE LINE REFRACTION
EMPLOYING A NEW MODEL OF THE
STANDARD TYPE OF TRIAL FRAMES



BY

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# PREFACE

The purpose of this book is to make known the System of Base Line Refraction adapted to the standard trial sets in common use.

The contents of this book will be included in "A Manual on Spectacle and Eye Glass Fitting" now in the course of preparation by the author.

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## CHAPTER I

# INTRODUCTION

THE system of BASE LINE REFRACTION has for its object the firm placing of the ophthalmic correcting lenses in the identical position before the patient's eyes as was occupied by the test lenses during the course of the refraction. The system is a practical method, concerning itself with establishing agreement in position of the test lenses and the correcting lenses, particularly as regards:

I. Precision of Cylinder Axes.
II. Height of Optical Centers.
III. Inclination of the Lens Planes.
IV. Distance of Lenses from the Corneas (Vertex Refraction).

The chapter on Vertex Refraction is purposely placed last although this phase of coördinating refraction with spectacle and eye glass fitting is receiving considerable attention by individual scientists and by those of national optical concerns. Meanwhile very rudimentary essentials to make the positions of trial lenses and correcting lenses actually and permanently to correspond have not been understood from a practical standpoint. These rudiments should be mastered first. Even the latest in present-day equipment does not insure that in the correcting spectacles we shall actually obtain the same position of the cylinder axis which

seemed correct at the test case. Such a problem and other practical aspects are therefore of primary importance, more so than a possible infinitesimal spherical difference between a test lens and the ophthalmic lens.

The principles of Base Line Refraction were explained by the author in the American Journal of Ophthalmology, July, 1920, and September, 1922, and a new trial frame was described.

In the present article these principles are further elaborated but employ widely used Trial Frame and Test lenses.

To coördinate Refraction with Spectacle and Eye Glass Fitting it is essential that there be established on the faces of patients certain fixed points which will first determine the position of the lenses in the trial frame and subsequently determine the identical position of the ophthalmic correcting lenses.

We will begin by establishing A BASE LINE ON THE PATIENT'S FACE opposite, and parallel to which and at the same height, first THE BASE LINE OF THE TRIAL FRAME, and then THE BASE LINE OF THE FINISHED SPECTACLES OR EYE GLASSES is firmly positioned.

# CHAPTER II

## THE BASE LINE OF THE FACE

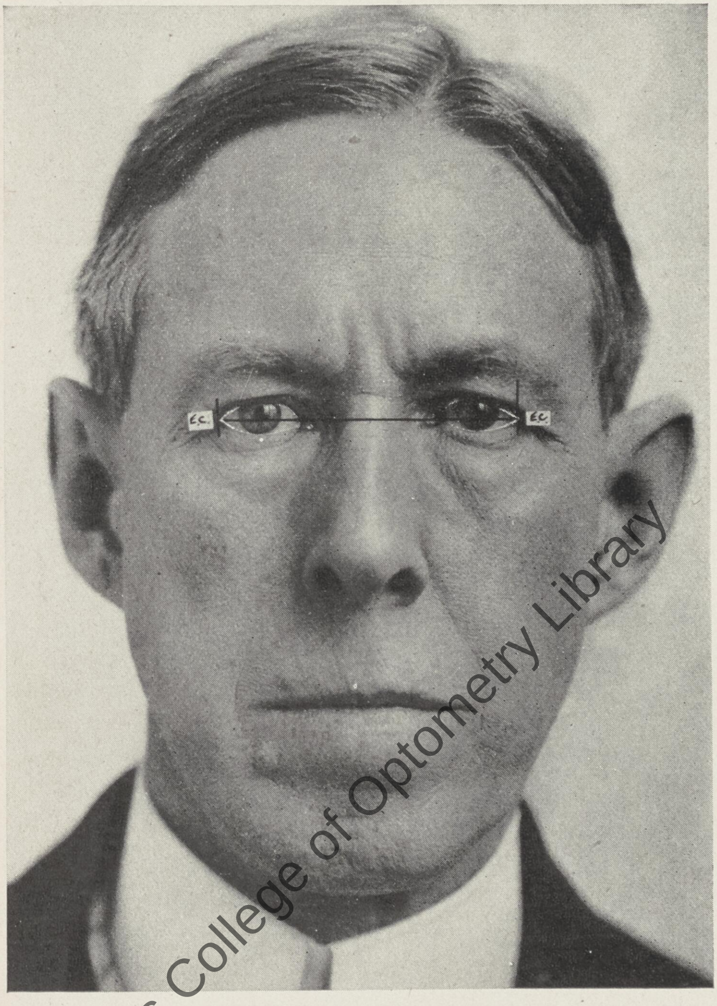


FIGURE 1. The black line extending from external canthus to external canthus (E C to E C) fixes the unvarying horizontal or BASE LINE OF THE PATIENT'S FACE. The internal canthi are disregarded.

THE BASE LINE OF THE PATIENT'S FACE extends invariably from the external canthus of one eye, continuously to the external canthus of the other eye. See Figure 1. THE INTERNAL CANTHI ARE DISREGARDED. (The canthus is the angle formed by the junction of the upper and lower lids.) Here is a constant, definite, continuous base line between two fixed points, in fact, the only lateral fixed points available. This line does not vary from day to day. The line is the same in all patients regardless of facial asymmetry, any kind of ocular deviation or EVEN THE ABSENCE OF ONE EYE. The more pronounced an asymmetry or a deviation, the more necessary is an unvarying Base Line. The refractionist determines the axes of the required cylinders as related to this definite base line. The correcting cylinders are positioned with axes as related to the same base line.

The eyeballs not being fixed, the pupils are therefore not stationary. The pupils cannot therefore serve constantly and invariably as landmarks for a Fixed 180 Degree Base Line, for positioning both the trial frames and the correcting lenses. The pupils cannot serve because their positions are altered in every movement of the head; they cannot serve in the presence of common ocular deviations or of nystagmus. Then also the pupils are often irregular, unequal or displaced. But if the trial frame is adjusted in relation to the Fixed 180 Degree Base Line, extending from the external canthus of one eye to the external canthus of the other eye, then we have a method universally applicable; then it is certain that the trial frame can be adjusted on a patient repeatedly in the same position at all sit-

tings; and that any other operator can and should adjust it in the identical position on that particular patient. It also makes it possible, and no other method does, for any informed optician to position the ophthalmic correcting lenses to correspond to that of the trial lenses.

THE TWO EYES OF EVERY PATIENT ARE AND MUST ALWAYS BE CONSIDERED TO BE ON THE SAME LEVEL, NO MATTER HOW ASYMMETRICAL THE REST OF THE FACE MAY BE. The nose may be bent, one cheek bone may be high, the mouth may be crooked, the chin irregular, one eyebrow may be more prominent, one ear may be low, but THE TWO EYES ARE ALWAYS ON ONE LEVEL. THE EYES ESTABLISH THE HORIZONTAL, INDEPENDENTLY OF ANY "ESTIMATED" VERTICAL. As far as refractionists and adjustments are concerned all other features except the eyes and the external canthi must be left out of consideration. Our horizontal base line extends forever and invariably from external canthus to external canthus.

As a matter of fact, this base line has been found in almost every instance to cross practically identical levels of the two corneas and to touch or be tangent to the lower margins of the undilated pupils. But notwithstanding that this sometimes seems not quite to be the case, be guided nevertheless invariably by the external canthi.

When there is considerable astigmatism some very careful refractionists retest for the cylinder axes with several different trial frames and prescribe at an intermediate axis.

When correcting cylinders of high power have been prescribed by eminent refractionists, it is quite com-

mon for good dispensing opticians to experiment a little, to arrive at the lens positions which give approximately the expected vision.

We propose to eliminate these examples of uncertainty and error.

Never should a trial frame be employed, one cell of which can be dropped to a lower parallel than its fellow of the opposite side. Such a trial frame and such a procedure brings about a hopeless incoördination of refraction with the spectacle or eye glass fitting. To persist in embodying this feature in trial frames will perpetuate a trouble-making error. Refractionists taking The Two Level View have absolutely no fixed points to guide them. Given an asymmetrical face, their axes are at one point today and at another tomorrow because they are unable to duplicate the position of the trial frame from day to day. They infer that the horizontal of the patient's face is at right angles to a vertical guess. And the spectacle frame fitter may make a different guess.

Practical men know that it is almost impossible to duplicate in a pair of spectacles or eye glasses the result as obtained with a trial frame, if a cell on one side was independently lowered. If occasionally, however, a coördinated adjustment so be achieved, then subsequent readjustments, though they be made in the same shop, are certain to destroy even the original pretense of accuracy.

An optician endeavoring properly to position a pair of frameless spectacles following a two level refraction would need to adjust so that the two screw holes of one lens are on a higher parallel than the two screw holes of the other lens. Let this pair of spectacles fall into

other hands, or, at a later date let them be returned to the original shop, even then the fronts will be aligned straight, with all four screw holes on one line and thus destroy the original attempt at accuracy. If a pair of bifocals with a cylindrical correction be ordered after a two level refraction the efforts of the optician to follow a prescriber are never satisfactory and at all times unfortunate. The two level way is not a system but is a lack of system. The two level way provides no guide as to where the 180 Degree or horizontal meridian of a face lies.

## CHAPTER III

# BASE LINE OF TRIAL FRAME

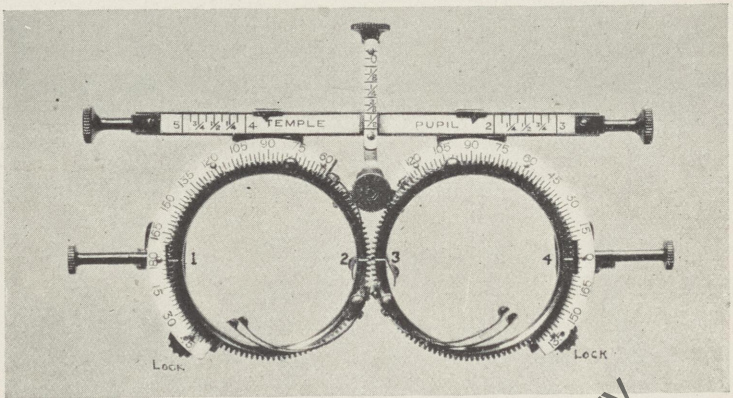


FIGURE 2. Trial Frame Front of New Model. Each of the toothed rings which carry the trial cylinders bears two distinct, geometrically opposite marks, 1, 2, 3 and 4. All four fall on one line, THE BASE LINE OF THE TRIAL FRAME.

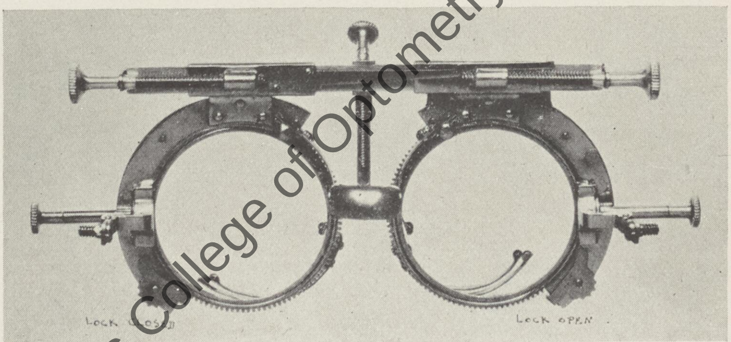


FIGURE 3. Rear view of New Model Trial Frame Front Showing Lock retaining notched rotatable ring in a fixed position.

FIGURE 2 shows the standard trial frame familiar to American refractionists. It has undergone modifications which enhance its accuracy and adapt it to Base Line Refraction.

Each of the toothed rings of the rotatable cells which carry the trial cylinders bears two distinct marks at geometrically opposite points, 1, 2, 3, 4.

The temporal marks 1 and 4 in the figure are brought opposite the 180 Degree marks of the axis scale and locked there. (See lock, Figure 3.) If the two eyes of the trial frame front are now brought toward each other, it is seen that the nasal marks 2 and 3 meet, and that all four marks 1, 2, 3 and 4 fall on one line. This line is the 180 Degree or Base Line of the Trial Frame.

The Base Line of a trial frame is ALWAYS A STRAIGHT LINE extending continuously across the trial frame front, PASSING THROUGH FOUR POINTS indicating the 180 Degree meridian. (Few trial frame fronts would be found in alignment were their 180 Degree meridians marked at all four points, which of course in the majority of trial frames is not the case.)

The two marks on each of the toothed rings, at geometrically opposite points are necessary to provide on this particular trial frame a means of verifying the alignment of the trial frame front. These marks also make it possible to verify the GEOMETRICAL OPPOSITENESS of the axis markings of trial cylinders. For that purpose one may insert trial cylinder pairs at axis 180 Degrees, while the toothed rings are locked in the same position. The four axis markings should now be on one line.

The marks on the toothed rings would be unneces-

sary if the axis arcs on this standard trial frame were complete circles or if the arcs were semi-circular and placed centrally below, as in some trial frames, including the one I described in 1920. But the axis arcs on this standard trial frame are placed up and out for very good reasons. The trial lenses are large and the scales so placed, do not interfere with bringing the lenses close together for a child, or for an adult with small interpupillary distance, or for an adult with an average interpupillary distance and a broad nose.

Working with a good sized cylinder trial lens at least makes for accuracy of the axis, whereas small trial cylinders have the disadvantage of working with a small arc, a change of 5 degrees being barely discernible. True, in some cases these small lenses have been placed in broad rings but they have not with unvarying success been placed centrally.

Referring again to Figure 2; when two trial cylinders are placed in the trial frame cells at axis 180, their four axis markings will accord with the marks designated 1, 2, 3 and 4 on the trial frame front. If all the four axis markings of the two trial cylinders thus fall on the 180 Degree Straight Base Line of the trial frame, then their axes will be true at BOTH POLES at any other axes than 180 Degrees to which they may be turned. If not true at 180 Degrees, at both poles, how can the readings be correct at other possible axes?

The four marks of any pair of trial cylinders can be made to fall on the base line only if the trial cylinders are properly marked.

Trial cylinders must be marked at GEOMETRICALLY OPPOSITE POINTS. If the trial lens is perfectly centered the marks will fall on the cylinder axis and simul-

taneously at geometrically opposite points. If the lens be not exactly centered the marks must nevertheless invariably be at geometrically opposite points and parallel to the cylinder axis. In this latter case, only a slight prismatic error is produced, which may be condoned in the low powers.

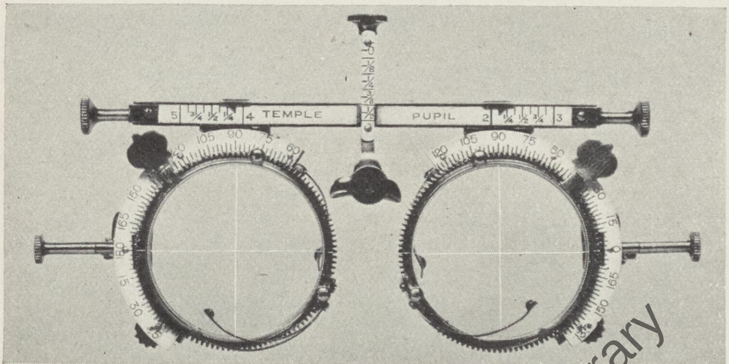


FIGURE 4. Shows New Model Standard Trial Frame with geometrically cross-lined lenses locked in place. The horizontal lines are sections of one straight line, extending across the trial frame front, the 180 Degree meridian of the trial frame. This is the Base Line of the Trial Frame.

Referring to Figure 4, notice the cross-marked lenses geometrically lined. They are put in place and locked when the trial frame is to be positioned on a patient's face. When the frame is properly positioned on a patient the vertical lines of the cross-marked lenses must, as nearly as possible, vertically bisect the pupils but the horizontal lines of the cross-marked lenses must absolutely be parts of a continuous straight line and each of these horizontal lines must be opposite to, at the same height as and must bisect the external canthus. Thus the continuous straight base line of the trial

frame is brought opposite and parallel to and at the same height as the base line of the patient's face.

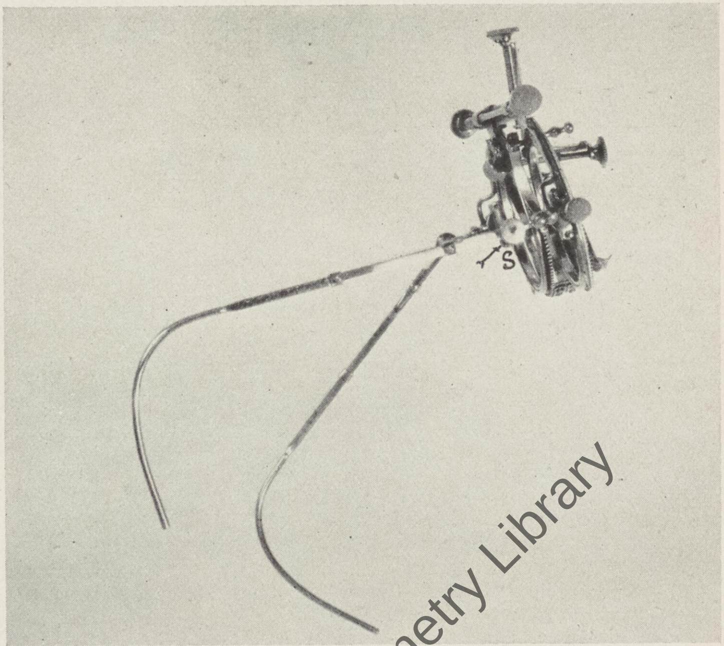


FIGURE 5. The Temples are separately adjustable to any tilt. The temple breaks at arrow point when screw "S" is loosened. Tilting one temple more than its fellow compensates for lowness of one ear or raises the corresponding end of trial frame front.

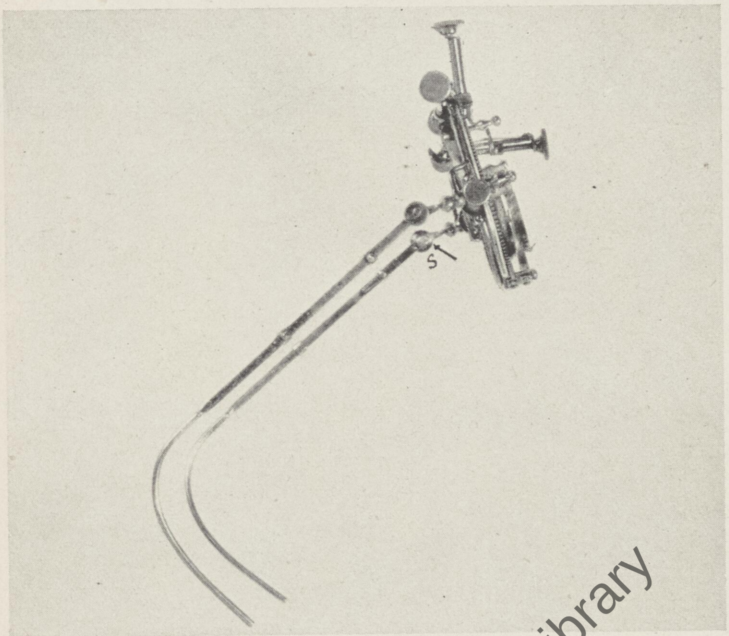


FIGURE 6. Tilting both temples equally tilts the trial frame front.

Figures 5 and 6 show the separate adjustability of the temples as to tilt. Each temple can be separately tilted, if the thumb screw "S" be loosened. Each temple can be fixed at any desired angle. Tilting both temples equally tilts the plane of the trial lenses forward from the top. Tilting one temple more than its fellow raises the corresponding end of the trial frame.

The purpose of this adjustment becomes apparent by referring to Figures 8 and 9.

Sometimes it is an ear that is higher than its fellow. In such cases, only a trial frame with separately adjustable tilting temples can take care of the asymmetry, so that the base line of the trial frame can be kept opposite to and parallel with the base line of the patient's face.

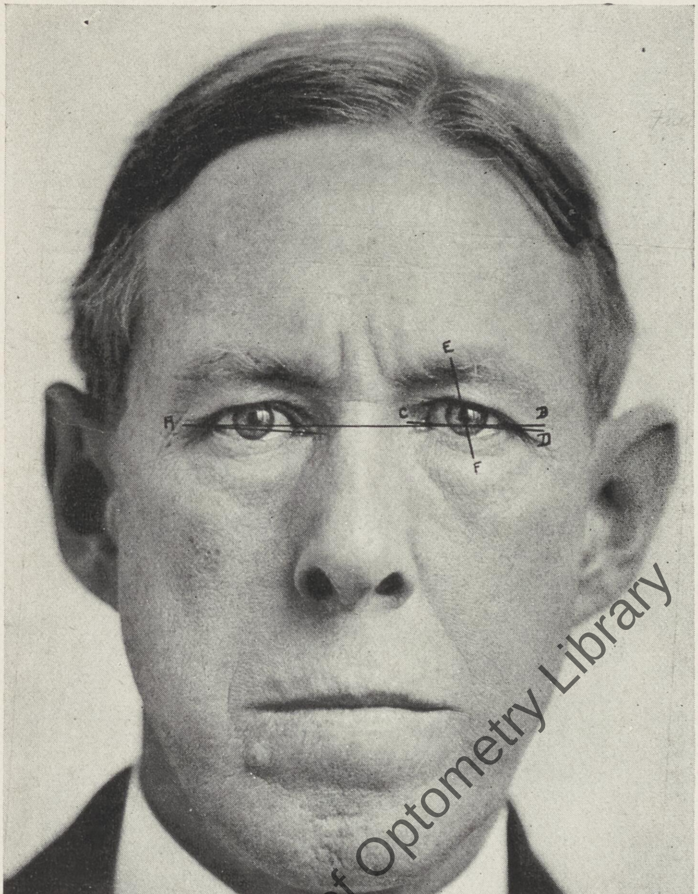


FIGURE 7. Patient with decidely asymmetric face. The left eye appears to be higher than the right. The lines show that a cylinder prescribed at axis of 105 degrees might, in this case, have more than one position according to the habit of the optician. The line E F cannot form an angle of 105 degrees with both lines, C D and A B. The continuous line A B is the one to which the continuous horizontal line of the trial frame, as well as the continuous horizontal line of the prescribed spectacles, must always be opposite and parallel.

Many faces are nearly symmetrical but few are absolutely so. The patient shown in Figure 7 has a decidedly asymmetrical face, the kind which is judged by the two level refractionists to have one eye higher than its fellow. This extreme case has been selected in order to emphasize the universality of the Base Line System.

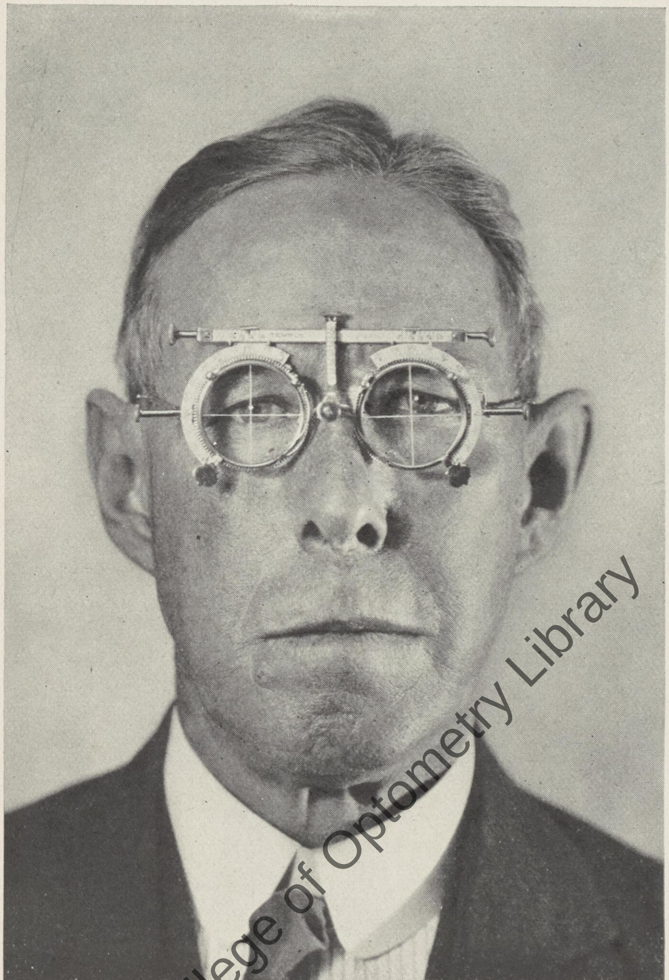

FIGURE 8. The same patient as in Figure 7, wearing old model standard trial frame. The horizontal of a patient's face is determined by the position of the eyes, or rather by the fixed points, called the external canthi. The horizontal is not determined by the ears, or any other asymmetrical features, or by a spirit level. A prescription for cylindrical lenses following so faulty a position of the trial frame as shown in this figure could not possibly be satisfactory.

Figure 8 shows this patient with the old model standard trial frame with non-tilting temples. Note its imperfect position. Cylindrical lenses prescribed following so faulty a position of the trial frame cannot be correct.

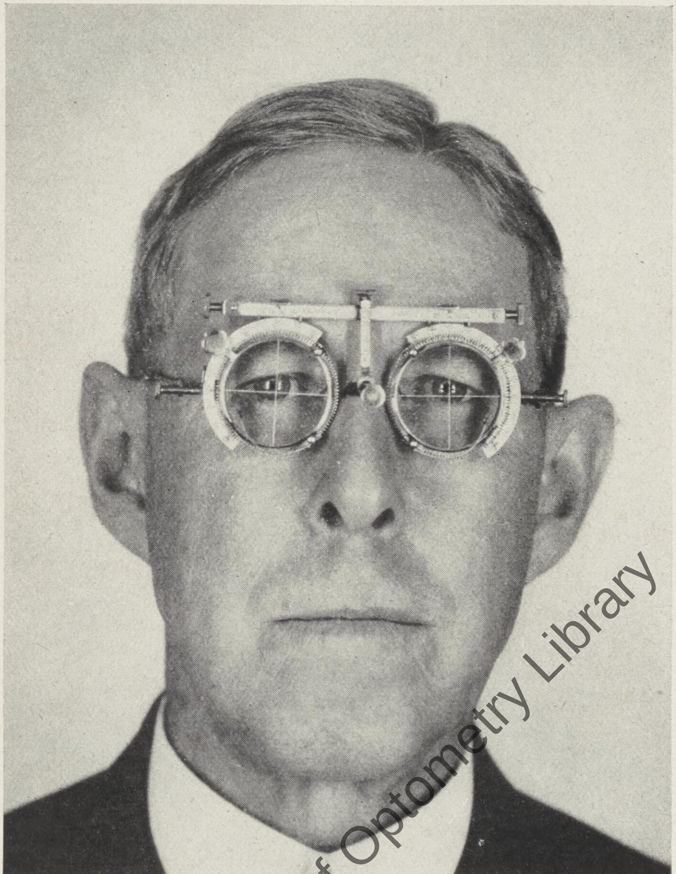

FIGURE 9. Same patient as in Figures 7 and 8. The left temple of the trial frame has been tilted more than the right, thus raising the left end of the trial frame front. There is no dropping of one trial frame cell to a lower parallel than its fellow. There is no such upset of the alignment. The four points indicating the horizontal meridian of the trial frame continue to be all on one line.

Each of the horizontal lines of the cross-marked lenses traverses an external canthus. The frame is now properly positioned so that its straight, continuous base line is opposite to, parallel with and at the same height as the base line of the patient's face.

Figure 9 shows the same patient but with the new model, standard, tilting-temple, trial frame. The left temple of the trial frame has been tilted more than the right. Now each of the horizontal lines of the cross-marked lenses traverses an external canthus and the frame is properly positioned so that Its Straight, Continuous Base Line Is Opposite to, Parallel with and At the Same Height as the Base Line of the Patient's Face.

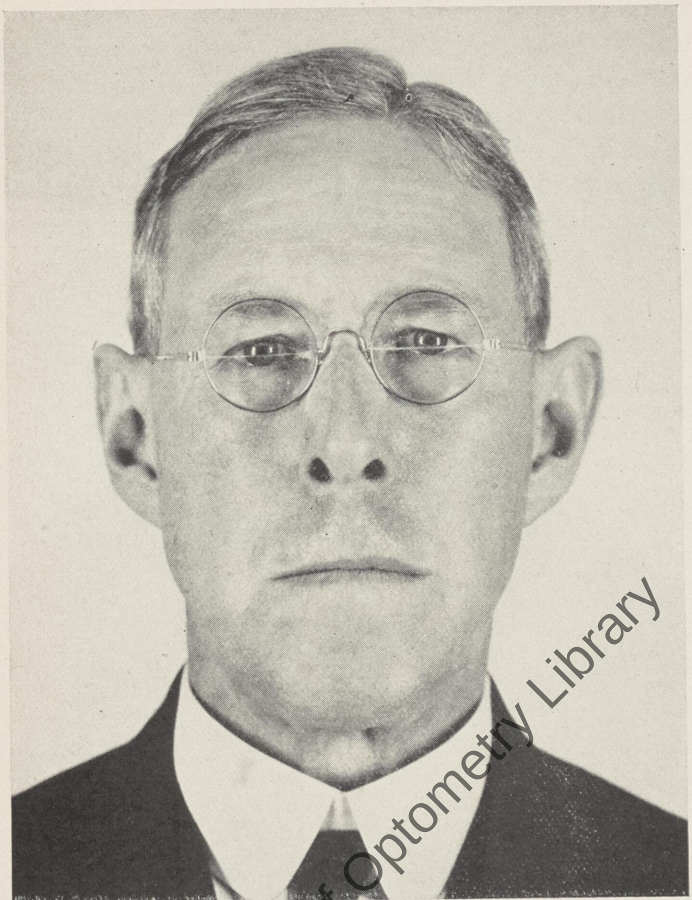

FIGURE 10. Patient properly fitted with a straight front pair of spectacles. Each of these round spectacle lenses is dotted with two permanent diamond dots, one near each end of the 180 Degree meridian of each lens. White pencil lines have been temporarily drawn between the dots. All these four dots fall on one continuous line. This line crosses each external canthus. The continuous horizontal line of the spectacles therefore coincides in position with both the continuous fixed horizontal Base Line of the Face and with the position which the continuous Base Line of the Trial Frame occupied during the refraction.

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Figure 10 shows this patient properly fitted with a straight front pair of spectacles. Each of these round spectacle lenses is dotted with TWO discernible diamond dots, one near each end of the 180 Degree meridian of each lens. White pencil lines have been temporarily drawn between the dots. All the four dots fall on one continuous line. This line crosses each external canthus.

CHAPTER IV

# HE BASE LINE OF SPECTACLES AND EYE GLASSES

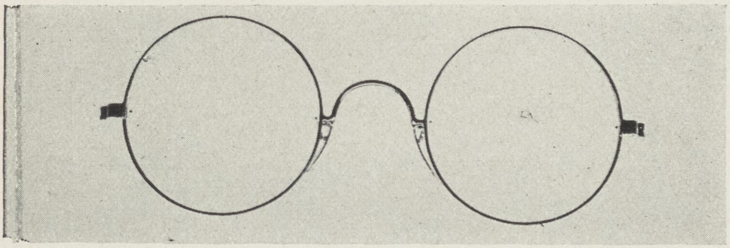

FIGURE 11. Wando Spectacle Front. Each lens in a spectacle or eye glass frame must be marked on its posterior surface by two discernible permanent diamond dots, one near the temporal end and one dot near the nasal end of the 180 Degree meridian. These four dots must always fall on one straight line.

EACH lens in a spectacle or eye glass frame must be marked on its posterior surface by two discernible permanent diamond dots, one dot near the temporal end and one dot near the nasal end of the 180 Degree meridian. These four dots must always fall on one straight line. One dot only, near the temporal end of each lens is positively not sufficient, because two dots so placed will not reveal faulty alignment. Four dots are essential. In frameless spectacles the four screw holes serve as these points. In frameless eye glasses drilled in center one discernible diamond dot near each temporal end is sufficient. The

screw holes take care of the nasal ends. If frameless eye glasses are drilled above center, two dots, one nasal and one temporal, are required on each lens on the 180 Degree meridians. These four dots falling on one line when the eye glasses are on the face constitute the Base Line. When eye glasses are adjusted or readjusted, it is required that the optician connect these diamond dots which indicate the horizontal meridians, by a white pencil line. The lenses are then to be positioned so that this—the straight base line—is opposite to, parallel with and at the same height as the Base Line of the face. The temporary white pencil lines on the lenses bisect the external canthus on each side.

At the first fitting, vertical white pencil lines through the geometric or the optical centers are also required. These verticals must appear opposite the pupillary centers. Figures 12, 13 and 14 with their legends demonstrate these points.

FIGURE 12. Cylinders must be set with axes in relation to the entire base line of either spectacles or eye glasses. In this figure, for instance, the cylinder axis X Y forms an angle of 105 Degrees, not only with the section C D but with the entire base line A D.

The base line A D is always a continuous straight line and is always opposite both external canthi and at the same height.

FIGURE 13. The position of the trial frame and the trial lenses predetermines the position of the correcting lenses. In every instance, the white lines as shown in Figures 13 and 14 must be drawn when the first adjustment is made. For every readjustment it is absolutely essential that the HORIZONTALS, between the ever-present dots, be marked by a white line.

FIGURE 14. The verticals and horizontals should be marked for the first adjustment. The horizontals must be marked for every readjustment. Any attempt properly to readjust cylindrical round lenses without marking the horizontals is a pretense.

CHAPTER V

# HEIGHT

THE horizontal base line previously designated determines the height of the centers of the trial frame lenses, and it determines the subsequent height for the centers of the lenses of the finished spectacles or eye glasses.

At first one should have the cross-lined lenses of the trial frame too close to the eyes so as to insure the oppositeness of the trial frame base line to the external canthi. Then use the forwarding screw and move the lenses forward enough to escape the eye lashes.

White pencil lines drawn across the horizontals of the ophthalmic correcting lenses must appear each opposite an external canthus. (See Figures 12, 13 and 14.) Lenses so positioned are found to be placed centrally before the natural bony aperture. These demands require a position of the lenses higher than the one to which opticians have heretofore been accustomed to adjust lenses and yet the base line is no higher than the lower margins of the undilated pupils. View the wearer's profile. If spectacle lenses are at the correct height the spectacle temple will be seen to bisect the external canthus, and this also is the height at which the refraction was done. (See Figure 9.) The continuous horizontal base line of the spectacles is not only op-

posite to, parallel with but also at the same height as the base line of the face.

I call attention again to this fact which, in connection with both height and tilt of lenses, must be given due consideration. Patients bring the depressors of the eye balls into action much more while the eyes are being tested than at other times. Ordinarily a book or paper is elevated, while at desk or lap work the individual inclines the head, neck and back sufficiently so that the eyes may be used in the position of greatest ease, namely as nearly as possible in the primary position (undepressed).

Therefore it is clear that glasses intended for reading only, need to be lowered but a trifle from the position already designated, nor do they require to be tilted beyond that line parallel to the bony orbit which is described in the next chapter. We allow for the inevitable inclination of head, neck and back. Readers do not maintain the eyeballs in a depressed position.

CHAPTER VI

# TILT

THE refraction must be done with the test lens planes at right angles to the lines of sight. The test lens planes must be tilted to the same angle at which the ophthalmic correcting lenses are to be worn. The angle of the test lens planes is not easily duplicated in the correcting lenses if the order merely read "tilt so and so many degrees." But if bony landmarks serve to fix the angle of the trial lenses and the same fixed points ever afterward guide the optician, then the right tilt will be reproduced at the first and at all subsequent readjustments.

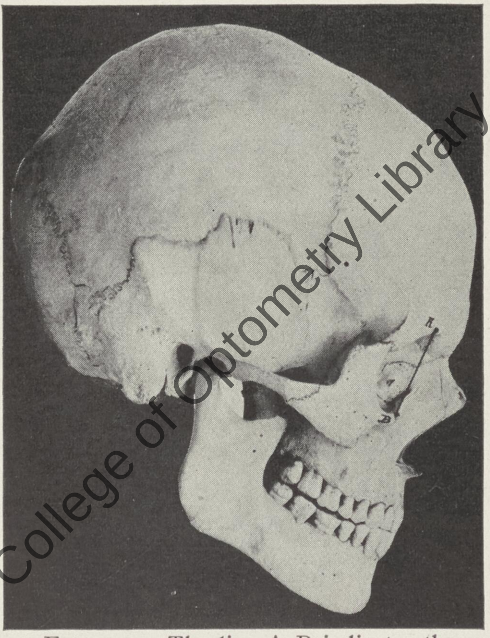


FIGURE 15. The line A B indicates the plane parallel to which, first the trial lenses and subsequently the ophthalmic correcting lenses in spectacle or eye glasses must be positioned.

Nature has supplied bony landmarks to indicate the tilt of both the trial lenses and the correcting lenses. In both instances the lens planes must be set parallel to a line extending from the center of the upper, sharp, thin, bony rim of the orbit to a corresponding point on the lower sharp, thin, bony orbital ring. The lens planes should be parallel, namely to the line A B on Figure 15. This is the natural bony orbital aperture. Agreement in tilt is thus made perfect as between the trial lenses and the correcting ophthalmic lenses. The principal axes of both correspond in direction.

Heretofore lens planes have been tilted only when the patient's ears happened to be located relatively high or when it has suited the habit or taste of the adjusting optician. The coördination of refraction with spectacle and eye glass fitting as far as tilt is concerned was impossible before the advent of trial frames with tilting temples adjustable to any certain position.

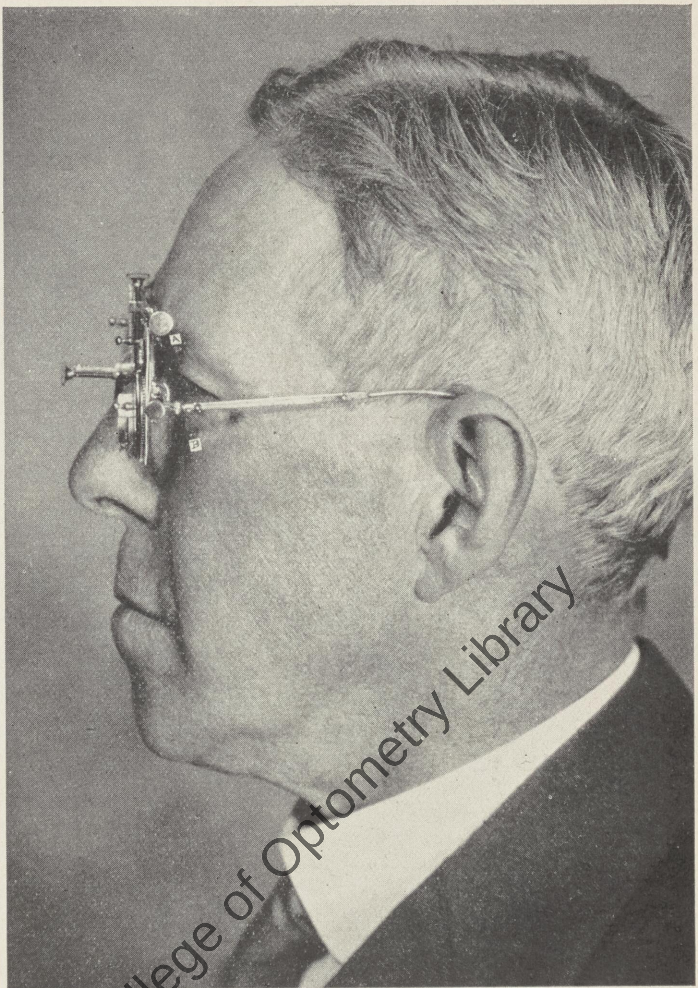

FIGURE 16. Position of old model standard trial frame, faulty as regards height and tilt. It is too low and not tilted to parallel the bony orbital rim, thus disagreeing with intended height and tilt of the ophthalmic correcting lenses in the finished spectacles or eye glasses. See improvement in next figure.

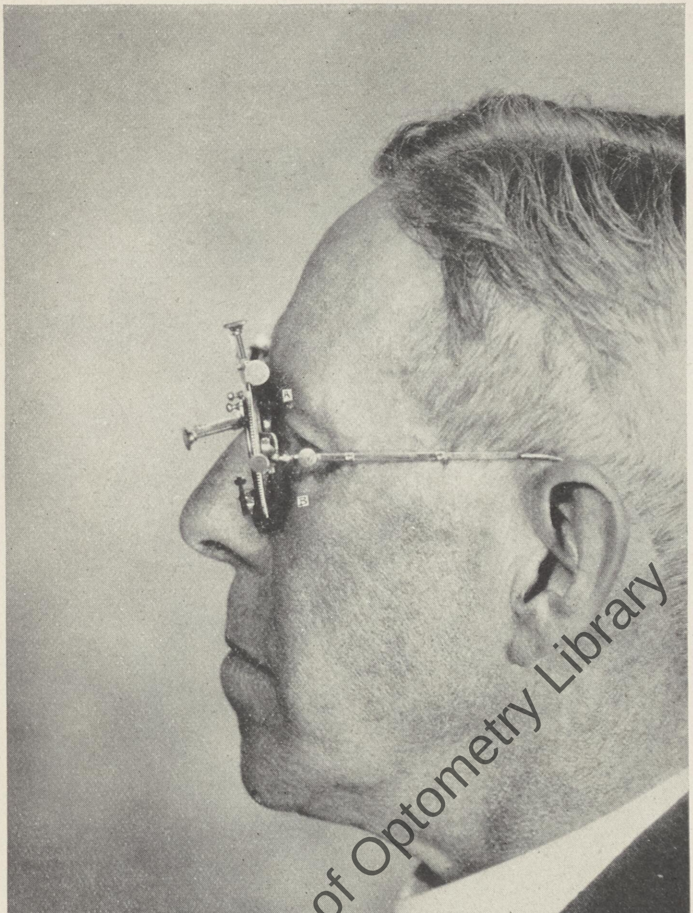

FIGURE 17. The New Model standard trial frame in correct position. The lenses are higher than they are in Figure 16 and their planes are tilted to parallel the bony orbital rim. Their planes parallel the line A to B. Their tilt corresponds to the intended position of the ophthalmic correcting lenses in either spectacles or eye glasses.

Figure 16 shows the profile of a patient wearing the old model standard trial frame without tilting temples. Its faulty position becomes apparent when comparison is made with Figure 17 showing the new model standard trial frame, with tilting temples, enabling us to adjust the planes of the trial lenses to parallel the bony orbit.

CHAPTER VII

# THE GENERAL ASPECT OF A WELL FITTED PAIR OF SPECTACLES

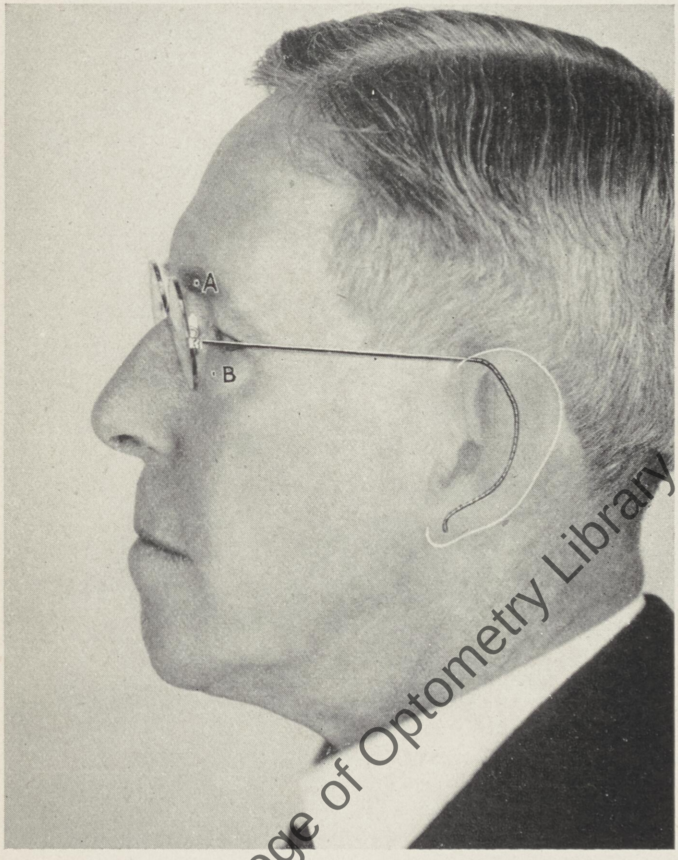


FIGURE 18. Patient fitted with white gold Wando Spectacles with flat eye wire. Note that the lens planes parallel the bony orbital aperture, namely a line from A to B. The temple shaft extends in a STRAIGHT LINE from the heavy end piece to the top of the ear. Then it curves sharply to follow the elevations and depressions in back of the ear. The spectacle temple shaft BISECTS the external canthus. The posterior surfaces of the lenses just escape the lashes.

NEXT view this patient fitted with a pair of spectacles, Figure 18. Note that the lens planes are parallel to the bony orbital aperture. Just so were positioned the planes of the trial lenses during the refraction. Note that the end piece of the frame is sturdy and that it is attached to the eye wire at an angle as shown in Figure 19. This temple has a heavy square butt and in this instance cable ends. The temple shaft extends In a Straight Line from the end piece to the top of the ear. Then it curves sharply and follows the elevations and depressions in back of the ear. The spectacle temple shaft is neither a quarter of an inch above nor a quarter of an inch below the external canthus but it Bisects the external canthus, which shows that the lenses are at the correct height, i. e., the height at which the refraction was done. The posterior surfaces of the lenses are just far enough from the eyes to escape the lashes, the same distance from the corneas at which during the refraction were the posterior surfaces of the posterior trial lenses. (See chapter on Vertex Refraction.)

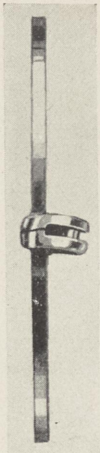

FIGURE 19. The end pieces on modern framed spectacles are attached to the eye wire at an angle so that the temples will assume a certain amount of tilt without being bent. Their tilt may, however, be increased or diminished. End pieces should be sturdy and temple shafts indisposed to yield.

## CHAPTER VIII

# VERTEX REFRACTION

THE new standard trial frame is used with the trial lenses which have been standard for many years and which at this writing are in almost universal use. The purchase of new sets of trial lenses is not advocated.

### CALCULATIONS EMPLOYED IN THE MANUFACTURE OF THE COMMONLY USED TEST CASE LENSES

In these lens sets the biconcave spherical lenses were made the "master" lenses. Because of their negligible central thickness their powers are almost minutely exact as measured from either of their surfaces or vertices. Therefore they fulfill within extremely close limits the requirements of vertex refraction.

The biconvex spherical lenses in these sets have been ground to their indicated focal powers NOT as measured from their cardinal points (one-third their thickness inward from the surface), for if this were the case they would not be neutralized by the negligibly thin "master" biconcaves.

But the biconvex spherical lenses in these sets for many years HAVE BEEN CALCULATED AND GROUND so that they ARE neutralized by the negligibly thin "master" biconcave lenses.

Therefore we find that their powers are almost minutely exact as measured from either surface or vertex. We elect to measure from the surface nearer the eye. These biconvex test lenses fulfill therefore within extremely close limits the requirements of vertex refraction.

If for instance we refract a hyperopic patient with one of these biconvex test lenses, the back surface of which is 14 mm from the cornea, and fill his prescription with a biconvex ophthalmic lens and place it 14 mm from the cornea, then we have given our patient the optical equivalent of the lens used in our refraction. The proviso is that the biconvex ophthalmic lens has also been calculated and ground to its indicated power, as measured from its back surface or vertex.

The real difficulty is encountered through the error which is introduced when we substitute for a biconvex test lens of a certain power, an ophthalmic lens of the same indicated power but of a different thickness or form, for instance a meniscus lens. But even this difficulty will be overcome: (1) if the meniscus is calculated and ground to its indicated power as measured from its back surface or vertex, and (2) if we place such a lens at the same distance from the cornea as was occupied by the test lens.

National manufacturers have been regularly supplying meniscus and toric lenses so calculated and ground since 1917.

Their effective powers are calculated from the surfaces which are intended to face the eye. Their effective powers are accurately measured by such instruments as the Lensometer.

Meniscus and Toric Ophthalmic Lenses, correctly

calculated and ground, cannot be exactly neutralized by the lenses of our test cases if these test lenses be placed in contact with their anterior surfaces.

But they might be neutralized by the lenses of our test cases were we able to apply these test lenses in contact with their posterior surfaces. But this is impossible.

We might neutralize them on their back surfaces with very small concave test lenses if we had them. Not having them, we must depend upon the Lensometer for exact measurement of effective power, as measured from their posterior surfaces.

## CHAPTER IX

# DISTANCE OF LENSES FROM CORNEAS

WE cannot measure the exact distance, 14 mm, cornea to back surface of test lens in every case we refract. There are test frames, however, for which claims to do this, are made.

We cannot demand this exact distance, 14 mm, cornea to back surface of ophthalmic lens on every prescription filled. There are scientific instruments, however, which will measure these distances.

Prescription opticians even of the very highest type will acknowledge the futility of promising to place and maintain the posterior surfaces of a pair of ophthalmic lenses exactly at any given number of millimeters from the corneal vertices.

We will presently describe a more practical method of making the corneal distance of ophthalmic lenses a duplicate of the corneal distance of the test lenses. *Agreement* in this respect is what we are after.

The specification of 14 mm as the correct distance between posterior lens surface and corneal vertex will prove correct in only a limited number of cases.

Refractionists know the desirability of placing strong minus corrections as close to the eyes as possible. Long lashes may make it necessary to move lenses off. Short lashes may permit the placing of the correcting lenses closer.

In the present system for the Coördination of Refraction with Spectacle and Eye Glass Fitting we employ fixed points for the identical positioning of both the trial lenses and the ophthalmic correcting lenses. A fixed distance for the phase of coördination now under discussion is available.

(1) The test lenses are placed just far enough from the eyes to escape the tips of the eye lashes in each individual case. Their posterior surfaces are just beyond the tips.

(2) The ophthalmic lenses are placed just far enough from the eyes to escape the tips of the eye lashes in each individual case. Their posterior surfaces are just beyond the tips.

(3) The test lenses are calculated and ground to their indicated power as measured from their posterior surfaces.

(4) The ophthalmic lenses, no matter what their form, must be calculated and ground to their indicated power as measured from their posterior surfaces.

The purpose of this book is to show how much further we can go with only slight modification of the equipment now in so common use. Not any of the practical principles here discussed can, however, be properly left out of consideration, in the further development of test case equipment or of ophthalmic lenses.